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Press Kit

Project FIRST SHUTTLE ORBITER
FREE FLIGHT TEST

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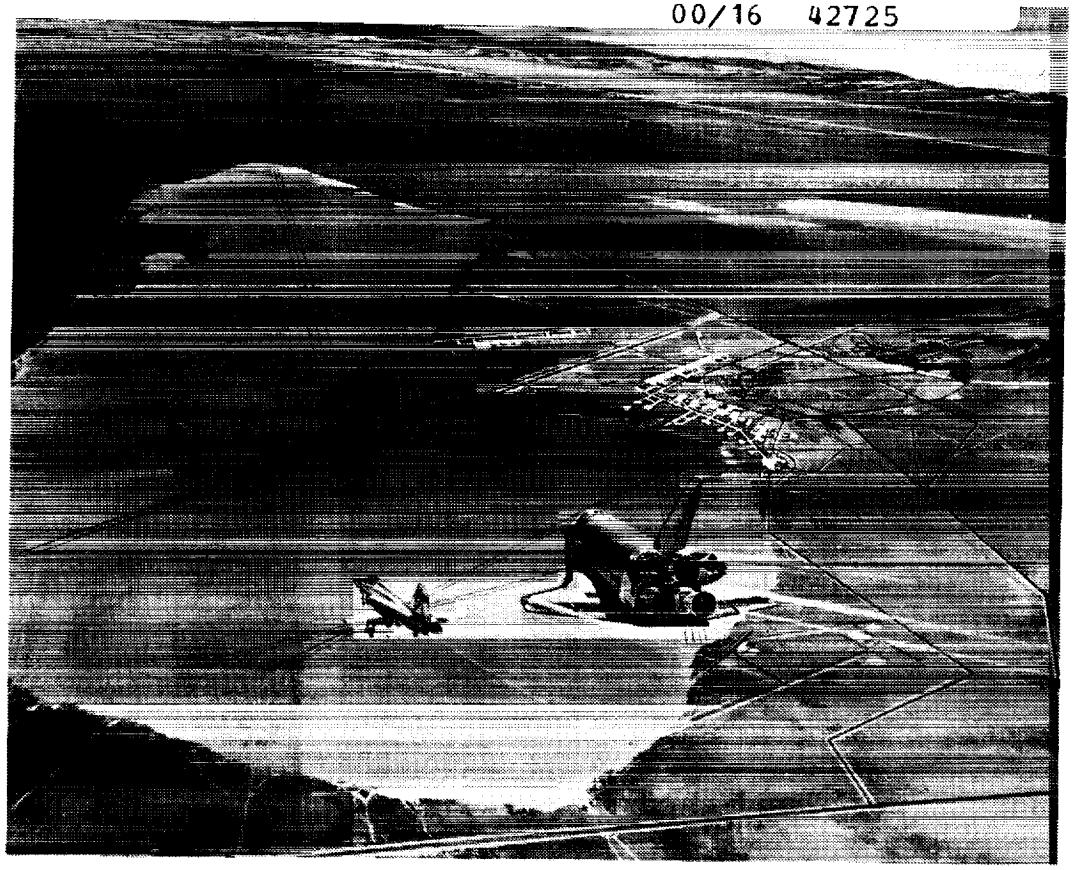

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For Release

IMMEDIATE

RELEASE NO: 77-160

FIRST SHUTTLE ORBITER FREE FLIGHT TEST SET FOR AUG. 12

Shuttle Orbiter Enterprise, with astronauts Fred W. Haise and C. Gordon Fullerton at the controls, will be released from atop a 747 carrier aircraft for the first free flight approach and landing test (ALT) at NASA's Dryden Flight Research Center, Edwards, Calif., no earlier than Aug. 12, 1977.

Haise and Fullerton will fly the 75-ton Orbiter to an unpowered landing on a dry lake runway after explosive bolts release the Orbiter from its 747 carrier aircraft at an altitude of about 6,738 meters (22,100 feet) above ground level. The free flight of the Orbiter will take about five minutes.

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Mailed:
August 3, 1977

This initial solo flight follows a series of unmanned and manned captive test flights conducted at Dryden which began in mid-February. The Orbiter was carried aloft for a series of five "inert" flights (Orbiter systems inoperative) before astronauts Haise and Fullerton and fellow ALT crew members Joe Engle and Richard Truly flew subsequent captive flights.

The captive flights verified the aerodynamic and handling capabilities of the 747/Orbiter combination as well as Orbiter systems and crew procedures.

Takeoff time for the flight is 8 a.m. PDT (11 a.m. EDT) with separation about 45 minutes later. The combined weight of the two vehicles is 265,350 kilograms (585,000 pounds).

Enterprise's first solo flight will generally follow this pattern:

The flight path of the Orbiter and 747 follows a racetrack pattern with separation occurring when the vehicles are about 13 kilometers (8 miles) to the right and flying parallel to the landing runway. From the separation point, the Orbiter will fly a U-shaped ground track to the runway.

To perform the separation maneuver, the 747 will pitch down to -6 degrees and accelerate to establish equilibrium glide conditions of 500 km per hour (310 mi. per hour) equivalent air speed (EAS) and -9.2 degrees flight path angle. At this point, the Orbiter pilot will initiate separation by arming and firing a series of explosive bolts at an altitude of about 6,736 m (22,000 ft.) above runway level.

At separation, the Orbiter crew will command a pitch up maneuver which will provide a vertical separation of more than 60 m (200 ft.) in about five seconds. The 747 will turn left while the Orbiter turns right to provide horizontal separation.

On the first flight the Orbiter will pitch down, accelerate to 270 KEAS and then perform a practice flare at 6,705 m (20,000 ft.) altitude, allowing the airspeed to decrease to 333 km/hr (207 mph) EAS to evaluate the flying qualities of the Orbiter at landing speed.

The Orbiter pilot will then pitch down to accelerate and, at the same time, initiate the first of two 90-degree turns to the left which will align the vehicle with a lakebed runway.

At completion of the second turn and 98 seconds from landing, the Orbiter is aligned with the runway at an altitude of 1,980 m (6,500 ft.) and about 14 km (9 mi.) from the touchdown point, 500 km/hr (310 mph) EAS flight path -9 degrees.

First flare starts at an altitude of 274 m (900 ft.) and transfers the Orbiter from the -9 degree glide slope to a -1.5 degree glide slope. The landing gear is deployed shortly afterward, between 60 and 90 m (200-300 ft.) altitude and the landing flare is initiated at slightly less than 30 m (100 ft.) altitude. The final flare establishes a sink rate of approximately 1 m (3 ft.) per second which is held to touchdown. Touchdown airspeed is about 180 km/hr (112 mph) EAS and elapsed time from separation to touchdown is about five minutes, 10 seconds.

During rollout various braking and steering methods will be evaluated at different speeds.

Astronauts Engle and Truly will pilot Enterprise during the second flight, tentatively scheduled for about three to four weeks later.

A series of free flights is currently scheduled with the Shuttle Carrier Aircraft(SCA-747) serving as the airborne platform from which the Orbiter will be launched. These flights, with NASA astronauts at the controls of the unpowered Orbiter, are designed to verify the Orbiter's subsonic airworthiness, integrated systems operations and pilot-guided and automatic approach and landing capabilities.

The Orbiter, workhorse of the Space Shuttle program, is designed to be used a minimum of 100 times. It is as big as a commercial jetliner (DC-9); its empty weight is 68,000 kg (150,000 lb.); it is 37.2 m (122 ft.) in length and it has a wingspan of 23.8 m (78 ft.). The Orbiter is to be launched into low Earth orbit in 1979 with its three main engines augmented by a pair of solid rocket boosters.

The Space Shuttle is composed of the Orbiter, the two solid rocket boosters and an external fuel tank which feeds the Orbiter's three engines.

The Orbiter is attached to the back of the fuel tank and the solid boosters are attached to each side of the external tank. The solid boosters will be recovered, refurbished and reused. The external tank will be jettisoned but not recovered.

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Enterprise, the first Orbiter (101) to be used in the Dryden flight test program, is the first development article of the Shuttle program to come off the assembly line. Under construction since June 19, 1974, Enterprise's main parts come from numerous aerospace contractors throughout the country. The crew module and aft fuselage were fabricated by the prime contractor, Rockwell International's Space Division, Downey, Calif.; the mid-fuselage (cargo bay) by General Dynamics, San Diego, Calif.; wings by Grumman Aerospace Corp. of Bethpage, N.Y.; and its tail assembly by Fairchild Republic Co., Farmingdale, N.Y.

The Orbiter's three main engines, each of which provide 2.1 million newtons (470,000 lb.) of thrust at launch, are being built by the Rocketdyne Division, Rockwell International, Canoga Park, Calif.

Enterprise was transferred from the Rockwell International assembly plant at Palmdale, Calif., to the Dryden Center Jan. 31, 1977. At completion of ALT, this first Orbiter will be ferried atop the SCA to NASA's Marshall Space Flight Center, Huntsville, Ala., where it will undergo extensive ground vibration tests. Subsequent to these tests it will return to the Rockwell facility at Palmdale and be prepared for orbital flight sometime in the early 1980s.

The second Orbiter (102), currently under construction, will be the first vehicle to be used in the Shuttle Orbital Flight Test (OFT) program which is scheduled to begin in 1979. Six OFT flights are planned to demonstrate the Orbiter's capabilities in Earth orbit before the Shuttle becomes operational in 1980.

ALT FREE FLIGHT TIMELINE

Event	Altitude**	T-Time*	PDT a.m.	EDT
Crew Wakeup		T-240	4:00	7:00
Crew Depart Quarters		T-210	4:30	7:30
Crew Arrives Trailer (physical & breakfast)		T-195	4:45	7:45
Crew Departs for Suitup Trailer		T-160	5:20	8:20
Crew Departs Trailer		T-125	5:55	8:55
Start Ingress		T-120	6:00	9:00
Ingress Complete		T-98	6:22	9:22
ALT Ground Team/Flight Team Handover		T-67	6:53	9:53
Orbiter/SCA Move From MDD***		T-62	6:58	9:58
Orbiter/SCA Tow to NASA Ramp		T-56	7:04	10:04
SCA Engine Start		T-42	7:18	10:18
SCA Begin Taxi		T-32	7:28	10:28
SCA Arrive Runway		T-12	7:48	10:48
Navigation Update		T-4	7:56	10:56
SCA Brake Release, Takeoff Climbout		T-0	8:00	11:00
		T+00		
Intersect Racetrack	16,905	T+13	8:13	11:13
FCS Checks***	22,705	T+24	8:24	11:24
Reach Maximum Climb Thrust	23,605	T+28	8:28	11:28
SCA Begin SRT Climb***	24,705	T+36	8:36	11:36
Pushover	25,905	T+45	8:45	11:45
		Separation Point		
Orbiter Separation	22,800	0:00	8:46	11:46
Initiate Practice Flare	20,600	0:26	8:46:26	11:46:26
Roll Left	18,000	1:41	8:47:41	11:47:41
Roll Left-Lineup on Runway	10,500	2:53	8:48:53	11:48:53
Turn Complete	6,400	3:54	8:49:54	11:49:54
Initiate Preflare	900	5:05	8:51:05	11:51:05
Deploy Gear	200	5:20	8:51:20	11:51:20
Touchdown		5:41	8:51:41	11:51:41

Note

* Events and times are preliminary and may change prior to and during flight and are dependent upon atmospheric and flight conditions.

** Altitudes are Above Ground Level (AGL) and are referenced to Orbiter ground aim point on the runway. Add 2,300 feet to AGL to obtain altitude above Mean Sea Level (MSL).

*** SCA - Shuttle Carrier Aircraft
MDD - Mate-Demate Device
FCS - Flight Control System (or Forward Crew Station)
SRT - Special Rated Thrust

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APPROACH AND LANDING TESTS SUMMARY RESULTS

PHASE I APPROACH AND LANDING TESTS
(Orbiter unmanned and systems inactive)

TAXI TESTS: February 15, 1977

Three taxi tests assessed the mated capability of the Shuttle Orbiter piggyback atop the 747 in ground handling and control characteristics up to the flight takeoff speed. The tests also validated the 747 steering and braking.

Weight of the 747 at the start of the taxi tests was approximately 400,000 lbs. and the Orbiter weight was approximately 144,000 lbs. The nose of the mated Orbiter is at a +6 degree altitude atop the 747.

The taxi tests were performed incrementally at various speeds. Taxi Test #1 speed was 89 mph and the 747 brakes were applied at 27 mph; Taxi Test #2 speed was 140 mph with the 747 brakes applied at 23 mph; and Taxi Test #3 speed was 157 mph with 747 brakes applied between 57 and 46 mph.

Successful completion of the taxi tests permitted the "go" for the first inert Orbiter captive flight.

FLIGHT #1: February 18, 1977

Duration: 2 Hr. 5 Mins.
Maximum Speed: 287 MPH
Maximum Altitude: 16,000 Ft.

This flight obtained information on low-speed performance and handling qualities of the mated "crafts" and was accomplished almost exactly as planned. The 747 combined with the Orbiter handled much closer to the standard 747 than was anticipated. The 747 crew stated "they couldn't even tell the Orbiter was aboard." The 747 mated with the Orbiter totals a much lower gross weight than a fully-loaded commercial 747 traveling from Los Angeles to London.

FLIGHT #2: February 22, 1977

Duration: 3 Hr. 13 Mins.
Maximum Speed: 328 MPH
Maximum Altitude: 22,600 Ft.

Flight #2 accomplished a series of flutter and stability control tests. During this flight, the two right engines of the 747 were reduced to idle thrust. The flight was termed "super."

FLIGHT #3: February 25, 1977

Duration: 2 Hr. 28 Mins.
Maximum Speed: 425 MPH
Maximum Altitude: 26,600 Ft.

This flight concluded the flutter tests and concentrated on stability/control/flight evaluation and airspeed calibration. Stability and control were evaluated by idling the #4 engine of the 747 to simulate an engine failure.

At the completion of this flight, it was stated that if flights #4 and #5 follow the same successful pattern, flight #6 would not be necessary.

FLIGHT #4: February 28, 1977

Duration: 2 Hr. 11 Mins.
Maximum Speed: 425 MPH
Maximum Altitude: 28,565 Ft.

This flight simulated emergency descent of the mated vehicles and a missed landing approach, as well as maneuvers required of the 747 when the mated vehicles enter the separation flight phase.

The emergency descent was accomplished by reducing the four 747 engines to idle thrust. The missed approach was performed by flying the mated vehicles over the runway within several feet of the ground, then returning the 747's four engines to power and flown around for the final approach and landing.

Full braking of the 747 was used for the first time upon landing in a simulated "short" runway situation. 747 braked to stop in less than 6,000 ft.

FLIGHT #5: March 2, 1977

Duration: 1 Hr. 39 Mins.
Maximum Speed: 474 MPH
Maximum Altitude: 30,000 Ft.

This flight performed two simulations of the flight profiles which will be used when the Orbiter is separated from the 747 in the third and final test phase. The two simulation release flights were performed successfully. Because an altitude of 30,000 ft. was reached it was possible to simulate the separation at about 25,000 ft.

In addition, the short runway landing was again achieved. This simulates NASA Marshall Space Flight Center's 7,500 ft. runway at Huntsville, Alabama. The mated vehicle configuration will be utilized to ferry the Orbiter to the Marshall Space Flight Center next year where the Orbiter will undergo a vertical ground vibration test program with the External Tank and Solid Rocket Boosters.

As a result of the success with the five flights, it was determined that the sixth flight was not required.

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PHASE II APPROACH AND LANDING TESTS
(Orbiter manned, systems active)

FLIGHT #1: June 18, 1977

SCA/Orbiter Brake Release:	8:06 A.M. (PDT)
SCA/Orbiter Landing:	9:01:46 A.M. (PDT)
SCA/Orbiter Weight:	263,088 Kilograms (580,000 lbs.)
Flight Duration:	55 Mins. 46 Secs.
Maximum Speed:	181 KEAS (208 MPH)
Maximum Altitude:	4562 Meters (14,970 Ft.)

Spacecraft Commander Fred Haise and Pilot Gordon Fullerton were at the controls of the Space Shuttle Orbiter during this first manned captive flight. This flight was a once around a racetrack-like flight path which measured approximately 125 kilometers (78 statute miles) on the "straight-a-ways" with 16 kilometer (10 statute mile) curves.

The Orbiter's onboard electrical power (fuel cells), auxiliary power units, hydraulic and coolant systems were activated prior to takeoff.

During the initial climb-out, low-speed flight control system tests were performed. When the mated craft reached approximately 4,562 meters (14,970 ft.), the SCA flaps were positioned to 10 degrees and speed was maintained at approximately 181 KEAS (knots equivalent airspeed--208 statute mph).

After the first turn of the racetrack-like trajectory, a flutter test was performed by the actuation of the Orbiter's flight control surfaces, then the SCA flight control surfaces; the Orbiter's speedbrake was opened to 60, 80, and 100 per cent; a test of the Orbiter's gyros was performed, and the Orbiter's flight control system and surface deflection were checked.

This first manned captive flight was orginally scheduled 24 hours earlier; however, during pre-flight checkout, three of the onboard computers "voted out" a fourth. This "rejected" computer was replaced. There are four onboard computers which operate redundantly to provide commands to the various Orbiter systems. According to mission rules, the Orbiter may be flown with three computers operating, but program officials decided to postpone the flight one day. There is a fifth computer onboard which operates a back-up flight control system independent of the other four for additional redundancy.

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FLIGHT #2: June 28, 1977

SCA/Orbiter Brake Release:	7:49:50 A.M. (PDT)
SCA/Orbiter Landing:	8:52 A.M. (PDT)
SCA/Orbiter Weight:	253,018 Kilograms (557,800 lbs.)
Flight Duration:	1 Hr. 2 Mins.
Maximum Speed:	270 KEAS (310 MPH)
Maximum Altitude:	6714 Meters (22,030 ft.)

Spacecraft Commander Joe Engle and Pilot Dick Truly were at the controls of the Space Shuttle Orbiter during this second manned captive flight. This flight consisted of a modified racetrack-like trajectory as well as a "Grand Prix" roadrace-like trajectory.

The Orbiter's onboard electrical power (fuel cells), auxiliary power units, hydraulic and coolant systems were activated prior to takeoff.

During the initial climb-out, low-speed flight control system tests were performed. This low-speed flutter test was performed with the Orbiter's flight control surfaces activated first, then the 747 SCA's control surfaces were operated with the mated craft at a speed of approximately 225 KEAS (259 mph). Following the low-speed flutter test, the Orbiter's speedbrake was opened to a 60, 80, and 100 per cent deployment.

The SCA crew then applied Special Rated Thrust (SRT) to the 747 engines for the climb, a pushover, and acceleration of the mated craft to approximately 270 KEAS (310 mph). The Orbiter and SCA crews again applied inputs to their respective craft control surfaces for a high-speed flutter test followed again by the deployment of the Orbiter's speedbrake at a 60, 80, and 100 per cent deployment. The low and high speed flutter tests assessed the accuracy of predicted control surface responses and structural characteristics with respect to aerodynamic vibration.

The mated craft then climbed again to an altitude of approximately 6,187 meters (20,300 ft.) for a separation maneuver test. The 747 crew accomplished a pushover and acceleration of the mated craft to approximately 270 KEAS (310 mph), with a descent rate of approximately 914 meters (3,000 ft.) per minute. The Orbiter's elevons and ailerons were positioned to provide the optimum Orbiter control surface positioning for the actual release maneuver in Phase III ALT.

Following the separation trajectory test, the mated Orbiter/SCA climbed again to approximately 5,882 meters (19,300 ft.), accomplished a pushover and established a 747 glide slope of approximately six degrees for an Orbiter AUTOLAND made fly-through. At this time the Orbiter crew monitored the Orbiter's Horizontal Situation Indicators which operated in conjunction with the MSBLS (Microwave Scan Beam Landing System). The combined craft then established a normal approach for landing.

The results of the flutter, separation maneuver and AUTOLAND tests were well within the tolerances expected by program officials.

FLIGHT #3: July 26, 1977

SCA/Orbiter Weight:	565,000 lbs.
Duration:	59 Mins. 53 Sec.
Maximum Speed:	312 mph
Maximum Altitude:	27,992 ft. (AGL)

Spacecraft Commander Haise and Pilot Fullerton were at the controls of Enterprise during this third and final captive flight, a full dress rehearsal of the planned August 12 free flight. The SCA/Orbiter reached a maximum altitude of 27,992 ft. (AGL) at which time pitch over was performed. The carrier aircraft landing gear was deployed to simulate the free flight approach and landing profile. A practice separation run was normal and "abort separation" was performed one minute after pushover. Enterprise landing gear was deployed for the first time after the SCA landed on runway 22. The final approach profile was identical to that planned for the first free flight.

ALT FREE FLIGHT 1

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22800	270	9	.5	SEP; $\dot{\theta}$ = 2°/sec, 3 sec; $\dot{\theta}$ = 0
2	0:03	22500	255	5	6	ROLL RIGHT ϕ = 20°; AT "CHASE TWO CLEAR," $\dot{\theta}$ = 1°/sec to θ = -10°, ROLL TO ϕ = 355°
3	0:26	20600	270	5	-10	AT AS = 270, INITIATE PRACTICE FLARE $\dot{\theta}$ = 2°/sec; HOLD $\dot{h}$ = 0 TO AS = 185
4	1:20	19500	185	11	11	AT AS = 185, $\dot{\theta}$ = -1°/sec TO θ = -4°
5	1:41	18000	200	9	-4	ROLL LEFT TO ϕ = 30°
6	2:30	13000	250	6	-4	AT ψ = 265°, ROLL TO ϕ = 0
7	2:50	11000	265	5.5	-4	AT AS = 265, $\dot{\theta}$ = 1°/sec TO θ = -3° TO HOLD AS = 270
8	2:53	10500	268	5.5	-3	ROLL LEFT TO ϕ = 30° TO LINE UP ON RUNWAY, ψ = 175°
9	3:54	6400	270	5	-2.5	TURN COMPLETE, HOLD AS = 270; SB-30%; $\dot{\theta}$ = -1°/sec TO θ = -4°
10	4:48	2000	270	5	-4	SB-CLOSE; $\dot{\theta}$ = 1°/sec TO θ = -2°
11	5:05	900	270	5	-2	INITIATE PREFLARE
12	5:20	380	250	6	4	AT AS = 250, DEPLOY GEAR
13	5:41	0	185	9	8	T.D. AS < 220; $\dot{h}$ < 10 fps
14	5:55	0	100	--	--	AT AS = 100, GENTLE BRAKING TO AS = 80
15	6:10	0	50	--	--	AT AS = 50, ENGAGE NWS

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